(12) UK Patent Application (19) GB (11) 2 376 915 (13) A

(43) Date of A Publication 31.12.2002

(21) Application No 0219355.5

(22) Date of Filing 20.08.2002

(71) Applicant(s)
Delcam Plc
(Incorporated in the United Kingdom)
Small Heath Business Park, BIRMINGHAM, B10 0HJ, United Kingdom

(72) Inventor(s)
David Stokes

(74) Agent and/or Address for Service
Delcam Plc
Small Heath Business Park, BIRMINGHAM, B10 0HJ, United Kingdom

(51) INT CL[7]
B29C 67/00 33/38 69/00 , B44F 1/06 , G05B 19/42

(52) UK CL (Edition T)
B5A AA2 ATXP AT3P A1R137 A1R165 A1R168 A1R314C2S A1R413 A1R428 A1R466 A20N1 A20TX A20T1 A20T3

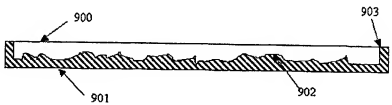
(56) Documents Cited
GB 2345458 A
JP 100101753 A
JP 020204506 A
US 4671890 A
JP 630020699 A
JP 040320478 A
US 6287492 A
US 4127689 A

(58) Field of Search
UK CL (Edition T) B5A AA1 AA2 ATXP AT3P
INT CL[7] B29C 67/00 69/00, B44C, B44F
Other: Online: WPI EPODOC JAPIO

(54) Abstract Title
Smooth surfaced lithophane

(57) Light is exposed to the rear of the lithophane, so that it can filter through the thin translucent sheet, which has variable thickness to modulate the light transmission properties and the translucent enamel/epoxy resin surface from which it is made to render an image. The lithophane comprises a translucent model made from a three dimensional geometric model of the lithophane using 3D printing (rapid prototyping) or CNC (computer numerical control) milling. An epoxy resin mixed with a translucent enamel hardener is poured over the lithophane model in cold liquid form and allowed to set. This creates the surface finish. The resin enhanced construction provides a durable smooth surfaced lithophane with good light transmission properties such that can be used to incorporate photographic either monochrome or true coloured images into durable manufactured objects such as memorabilia, jewellery, tombstones, collectors items, security devices etc.

Figure 4



GB 2 376 915 A

Drawings

Figure 1

Figure 2

Figure 3

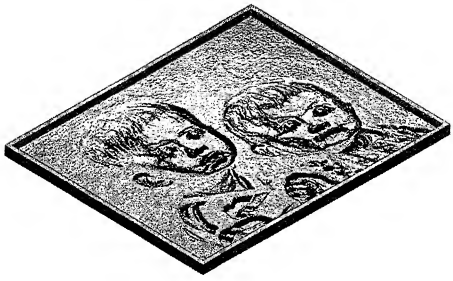
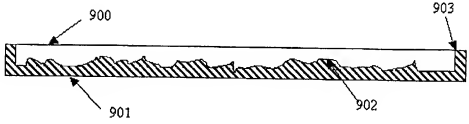


Figure 4



SMOOTH SURFACED LITHOPHANE

This invention relates to a smooth surfaced lithophane.

Lithophanes are pictures that need to be held up to light to display an image. They work in a similar way to watermarks; the thickness of a translucent material is varied so that when held up to light an image is formed.

It is known how to generate monochrome images by scanning photographs and then using the monochrome image to generate a lithophane. Such a process is described in patent applications such as EP 1 119 448. Further it is know how to manufacture the lithophane in translucent material with variable thickness corresponding to the local light intensity value either directly using CNC milling for example or a fabrication process known as rapid prototyping (3D printing) or alternatively by a moulding process such as described in EP 1 119 448 or a pressing process such as described in patent number US6287492.

A lithophane is attractive as an artefact containing a photographic likeness for example of a person and this can be used for example in memorabilia, jewellery, tombstones, collectors items, security devices etc. However lithophanes can suffer from poor mechanical strength because the thickness of the translucent material may need to be small to allow adequate light transmission. In addition one surface of the lithophane is typically heavily textured, because of the thickness variations necessary to modulate the light intensity to replicate the monochrome image, and this may be disadvantageous in the applications mentioned above.

According to the present invention, there is provided a system arranged to model the 3D geometry of the lithophane comprising an image capture means such as a digital camera or a photograph scanner, processing circuitry to convert the image into the 3D variable thickness relief such as a computer system executing the ArtCAM Pro software developed by Delcam Plc, a suitable translucent material

such as wax or paper or polymer or ceramic and a rapid prototyping machine or 3D printer such as the Thermojet developed by 3D Systems Inc. or a CNC milling machining tool, a hard clear setting substance such as glass or liquid epoxy resin and translucent enamel hardener such as is supplied by Acuflow. The lithophane image may be single coloured or may have a true colour appearance if the 3D printer is capable of fabrication using translucent material in at least three colours.

Such a system is advantageous because it helps to automate the process of generating smooth-surfaced, mechanically strengthened lithophanes in the form of a thin variable thickness sheet with good light transmission properties protected by a supportive resin layer.

Such a system has the advantage that the enhanced lithophane produced may be used to incorporate photographic images into durable manufactured objects such as toys, memorabilia, jewellery, tombstones, collectors' items, security devices etc.

The manufacturing process for the invention will now be described by way of example only of an embodiment of the present invention with reference to the accompanying images in which: -

Figure 1 shows the smooth surfaced lithophane when light is exposed to its back face.

Figure 2 shows the grey-scale image captured by a digital camera or photograph scanner and stored on the computer system in JPEG image file format from which the wax-resin lithophane is created using ArtCAM Pro software.

Figure 3 shows the three dimensional inverted relief created from the JPEG image data, with an added border, using the ArtCAM Pro software.

Figure 4 shows a section through a smooth surfaced lithophane.

Referring to the images, the lithophane, as shown in Fig 1, comprises a translucent model made from a three dimensional geometric model of the lithophane represented by a triangulated mesh model stored in STL format using a Thermojet or CNC milling machine tool, and an applied surface finish. An epoxy resin mixed with a translucent enamel hardener is poured over the wax model in cold liquid form, and then left to set (900 in Fig. 4). This creates the smooth surface finish with minimal attenuation of the light transmitted through the object. Light is exposed to the rear of the lithophane (901 in Fig. 4) to render an image.

In order to create the STL model from which the wax model is machined, an image file (*.bmp, *.tif, *.gif or *.jpg) as shown in Fig 2 is created by a digital camera or photograph scanner and is imported into the ArtCAM Pro software.

A Z height is defined for the imported image to set the maximum depth of the relief that ArtCAM Pro automatically calculates from the image. A relief is made up of a grid of points in a similar way to a bitmap image. However each point is assigned a specific height that depends on the intensity of light transmission necessary at that point to replicate the original photographic image. It may also have a colour value if required by the fabrication process.

The relief is inverted in the Z-axis to make it negative. A greyscale image of the relief is created, and a border applied to it. A height is applied to the border area, and this is combined with the inverted relief, as shown in Fig 3. In Fig. 4 it will be seen that the border area 903 acts as a bed in which to contain the epoxy resin/enamel hardener mixture 900 that is poured over the variable height manufactured surface 902.

The three-dimensional computer representation of the geometry of the relief and bounding detail is converted into a closed triangle model with a flat plane as its back face is created using the Mesh Creator tool in ArtCAM Pro. It is then saved as an STL model file, which is then sent to a 3D printing machine capable of fabricating objects in translucent material such as the Thermojet or it is used to generate milling cutter toolpath instructions using a computer executing CAM software such as ArtCAM Pro or PowerMILL from Delcam and the toolpath instructions are transmitted to a CNC milling machine tool. Alternatively the three dimensional computer representation of the geometry of the relief and bounding detail can be inverted to create a mould or die with which to mould the lithophane in the translucent material as is described in patent EP 1 119 448 or a pressing process such as described in patent number US6287492

It will be appreciated that in order to keep manufacturing costs and times low it is advantageous to fabricate multiple lithophanes for the same or different photographic images at the same time if the 3D printer is the preferred manufacturing machine. This is due to the layer-by-layer build up approach.

The translucent lithophane object is removed from the machine tool or the mould or the die and an epoxy resin mixed with a translucent enamel hardener is poured over the lithophane model in cold liquid form, and then left to set. This creates the surface finish.

Light is exposed to the rear of the smooth surfaced lithophane to render an image

CLAIMS

1 A smooth surfaced monochrome lithophane comprising a thin variable thickness sheet of translucent material manufactured by 3D printing or CNC milling and a surface finish created from an epoxy resin in cold liquid form mixed with an enamel hardener, left to set.

2 A lithophane substantially as described herein with reference to Figures 1-3.

3 A smooth surfaced lithophane as claimed in Claim 1 but including a thin variable thickness sheet of translucent material manufactured by moulding or pressing instead of 3D printing or CNC milling

4 A smooth surfaced lithophane as claimed in Claim 1 but where the thin variable thickness sheet of translucent material is fabricated by 3D printing as a composite of coloured particles to produce a true coloured image when held up to the light.

Application No:	GB 0219355.5	**Examiner:**	Monty Siddique
Claims searched:	1 (with first option) and 4	**Date of search:**	20 November 2002

Patents Act 1977
Search Report under Section 17

Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.T): B5A (AA1, AA2, AT3P, ATXP)

Int Cl (Ed.7): B29C 67/00 69/00; B44C; B44F

Other: Online: WPI EPODOC JAPIO

Documents considered to be relevant:

Category	Identity of document and relevant passage		Relevant to claims
Y	GB 2345458 A	(MYSTIX) page 2 and lines 35-37; page 3 and lines 8-10, 16-17, 20; page 4 and lines 11-12, 27-31; page 5 and lines 22, 26; page 6 and lines 10-11; page 7 and lines 12, 15-16, 26, 34, 36-37; page 8 and lines 1-2, 6-9 etc.; translucent plastics undergoes 3D printing to produce a mould/substrate etc.	1 with the first option of 3D printing and 4
A	US 6306470 B1	(GOLDFARB ET AL)	
A	US 6287492 B1	(GOLDFARB) compression moulding a translucent material into a work W and finishing the face 6 by element 7	
Y	US 4671890	(MITSUI) see abstract; use of cold setting epoxy resin containing a hrdener	1 with first option and 4
Y	US 4127689	(HOLT) abstract; column 1 and lines 60-61; column 2 and lines 14-15, 18-19; column 5 and lines 24-30; claims 1, 3 etc; forming an epoxy resin on a translucent substrate	1 with the first option and 4

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.

Application No: GB 0219355.5 **Examiner:** Monty Siddique
Claims searched: 1 (with first option) and 4 **Date of search:** 20 November 2002

Category	Identity of document and relevant passage		Relevant to claims
Y	JP 630020699 A	(DAINIPPON) heat curable epoxy resin formed on translucent base	1 with first option and 4
Y	JP 040320478 A	(SHOWA) see abstract; use of cold setting epoxy resin containing a hardener	1 with the first option and 4
Y	JP 020204506 A	(KENETSU) see abstract; use of cold setting epoxy resin containing a hardener	1 with first option and 4

X Document indicating lack of novelty or inventive step
Y Document indicating lack of inventive step if combined with one or more other documents of same category.
& Member of the same patent family

A Document indicating technological background and/or state of the art.
P Document published on or after the declared priority date but before the filing date of this invention.
E Patent document published on or after, but with priority date earlier than, the filing date of this application.